

Scientific Evaluation and Assessment
of ASL Developed Moist Atmosphere
Models for Low Stratus Subclouds

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Prof. Dr. Gottfried Hänel
Institut für Meteorologie und Geophysik
Feldbergstraße 47
6000 Frankfurt am Main
F. R. Germany

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Report on the papers "Moist haze microphysics profile model" (Paper I) and
"A similarity model for moist haze" (Paper II) by Henry Rachele and Neal
Kilmer and on the discussion I had with Mr. James Lindberg from White Sands
Missile Range during June 18 and 19 in Frankfurt:

The problem is to describe the thermodynamics and haze microphysics of the
subcloud layer. This is extremely difficult if the cloud is low and the
lower boundary of the subcloud layer is the ground like in the present
case. In such a case an adequate description of the turbulent processes in
the subcloud layer is necessary to get reliable results. The related
problems are difficult because the condensation processes have a
considerable influence on turbulence. Unfortunately the solution of this
problem is not found in the literature. The work of the authors is
important for the design and operation of electro-optical systems.

Both papers are valued as very good first approximations to an extremely
complicated problem. After having read the papers I sent some comments to
the authors. Their replies and changes of the model have been discussed
during and reviewed again after the visit of Mr. Lindberg in Frankfurt.

In summary the present model theory is a considerable improvement of the
theory in the papers I and II mentioned above. There have been made some
minor changes which need not to be mentioned. The most important
improvements are the consideration of condensational and of ground
roughness effects on turbulence.

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During his visit in Frankfurt I have discussed with Mr. Lindberg the present state of modelling, further improvement of the model theory, and experimental verification of the model.

Suggestions concerning improvement of theory:

1. At relative humidities larger than about 98 percent equilibrium thermodynamics becomes inapplicable to medium size and large particles. Because of the slowness of water vapor diffusion these particles will remain smaller than in equilibrium (G. Hänel, Contrib. Atmos. Phys. 60, to be pub. 1987). The results by W. Seidl and G. Hänel ("Einflüsse von Aerosoleigenschaften und meteorologischen Parametern auf die Entstehung von Nebel und Wolken", Abschlussbericht, Bundesminister für Forschung und Technologie, Forschungsvorhaben 423-4007-0704570 8, 1986) have shown that the model could be improved implementing non-equilibrium thermodynamics approximately.

2. The ground is a sink for particles. Thus it should be considered that the particle concentration increases with height (compare D. J. Carruthers and T. W. Choularton (1986), Quart. J. R. Met. Soc. 112, 113-129).

3. Improved aerosol models should be used for the computations. Details concerning this will be discussed during my visit in White Sands Missile Range.

Experimental verification of the model:

Comparison of measured and computed liquid water profiles in the subcloud layer yields that there should be an agreement between present theory and reality within a factor of about 3. Considering the errors of measurement and the above mentioned suggestions this agreement is valued to be very good and promising. Further steps of improvement of the model and its final version should be checked by well designed experiments. Since the model has to be verified in many details the related experiments will be not cheap. To reduce costs to a minimum the following strategy is suggested:

1. Make sensitivity studies with the present model to determine the minimum experimental information necessary and to get an insight how accurate this information has to be.

2. Compare the present model with the presently available incomplete data sets to learn which features have to be improved and what the approximate magnitudes of the necessary improvements are.

3. Improve the model and compare again with the presently available data.

4. If these comparisons yield satisfactory results make sensitivity studies with the improved model and design the verification measurements.

This strategy and related details should be discussed during my visit in New Mexico this August.



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